Rethinking the Framework: Consideration of Cumulative Effects in (bio)monitoring in the Lower Grand River and Nearshore Lake Erie

GRFMPIC Presentation | Elaine Ho, PhD Candidate, University of Waterloo

Supervisors: Dr. Simon Courtenay and Dr. Andrew Trant

Lake Futures: Dr. Nandita Basu (Principal Investigator) and Dr. Mark Servos (Work Package Lead)

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May 2, 2018

About me: Elaine Ho, PhD Candidate

- Hons. Bachelor of Environmental Studies – honors thesis in conservation ecology
- Master of Environmental Studies – impact of youth in Canada
- Exploratory study for PhD – review of monitoring indicators and reporting in the Muskoka River Watershed
  - Review of Report Cards
  - New criteria-based ranking process for refining indicators

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Overview

1. Research context (and questions for you to keep in mind)

2. Introduction to my research (current design)

1. Ideas on possible synergies with GRCA/GRFMPIC

1. RESEARCH CONTEXT

- And questions to keep in mind

Vocabulary (in my context)

- **Cumulative Effects (CE)**:
  - Collecting, accruing, and/or combined changes
  - Experienced at the same time in the same social-ecological system/area
  - Caused by past, present and (in the case of prediction) reasonably foreseeable future actions, both natural and human

- **Cumulative Effects Monitoring**: process of measuring and interpreting accumulating change/CE relative to established limits.
  - Often followed by predicting future CE
  - Goal is to act – prevent, understand and respond to (undesired) change

Context of the research

- **National/Binational**
  - Resurfacing algae (and other) issues in the Great Lakes
  - Canadian monitoring starting to require cumulative effects (Canadian Water Network/CWRC)

- **Global Water Futures – a nationwide research initiative**
  - 18 universities and colleges, including: University of Saskatchewan (host), University of Waterloo, McMaster University, Laurier University
  - Canada First Excellence Research Fund - $77.84 million (Sep 2016); *total funding $143.67 m*
  - Global Water Futures > User-centered solutions ('Pillar 3') > UW > Lake Futures
  - Three years Canadian context, four years international implications

Context of the research (cont'd)

- **Local**
  - Ontario is developing a Watershed Planning Guidance document
  - Ontario is revising four land use plans:
    - Growth Plan for the Greater Golden Horseshoe*
    - Greenbelt Plan*
    - Oak Ridges Moraine Conservation Plan*
    - Niagara Escarpment Plan
  - GRCA revising 5-year Strategic Plan, GRFMP 20th anniversary

** Revision includes focus on water resource protection, stormwater management, and/or watershed health*

Keep in mind…

- What are **your thoughts** on the general direction and approach of the research?

- How can we best **collaborate**?
  - How can the research support GRCA's review of its strategic plan and GRFMPIC's goals for the Plan's 20th anniversary?

2. RESEARCH INTRODUCTION

- And timeline

Introduction to my research

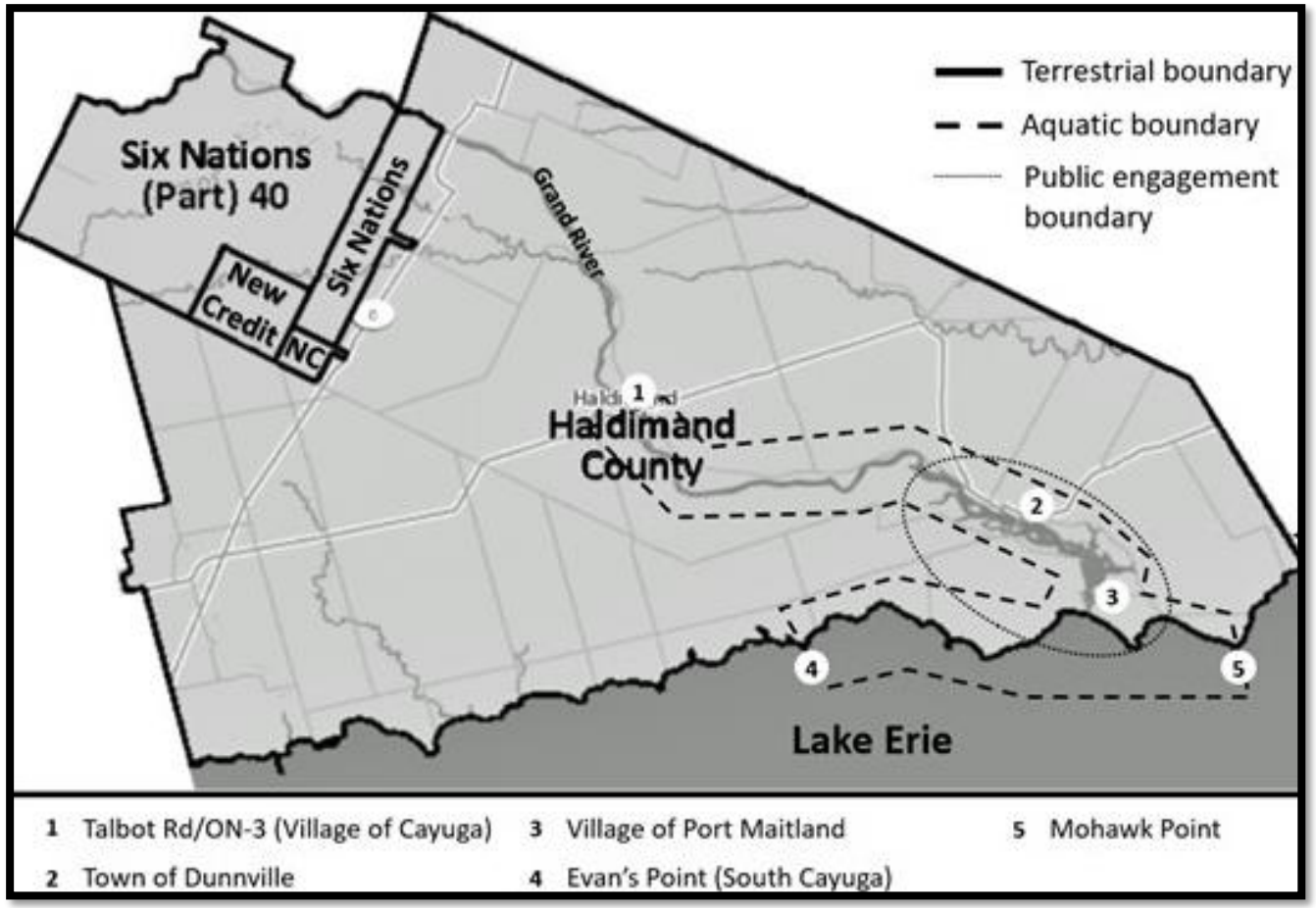
- **Goal**: strengthen, better coordinate and update surface water monitoring in the lower Grand River and nearshore Lake Erie (the Grand-Erie Interface, or GEI)

- **Objectives**: incorporate cumulative effects (CE), better coordinate monitoring partners, inform decisions, update valued ecosystem components (VECs)

- **Outcomes**:
  - Outline/co-create a viable framework for improved monitoring with key stakeholders
  - CE case study – using existing data in different ways to understand algae problem

Study area

- Aquatic area, the GEI (monitoring)
  - Grand River from Cayuga to Lake Erie
  - Lake Erie from Evan's Point to Mohawk Point, out to the 10m bathymetry line
- Terrestrial area (decision-making)
  - Haldimand County
  - Six Nations of the Grand River First Nation Reserve
  - Mississaugas of the New Credit First Nation Reserve



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Timeline – monitoring framework

- **Co-creation of improved monitoring framework**

  i. Map existing monitoring efforts: *in progress*, complete by October 2018.

  ii. Review global best practices in monitoring and cumulative effects: *in progress*, the bulk of this to be completed by October 2018 (but is ongoing).

  iii. Interviews with key informants –improving monitoring and informing decisions: *pending* ethics approval, expected timeline May-October 2018.

  iv. Public consultation (Dunnville) to update/highlight VECs in the study area: expected timeline March-August 2019.

  v. Co-create (bio)monitoring framework with key stakeholders (e.g., monitoring partners): expected timeline February-April 2020; stakeholder workshop expected February 2020.

Timeline – cumulative effects/data case study

- **Using existing data in different ways to understand the Lake Erie algae problem: March 2018 – August 2019**

  i. Compile existing data from partners: *in progress*, complete by December 2018

  - Provincial Water Quality Monitoring Network – *obtained* except 2017 data (pending).
  - Grand River Conservation Authority – *in progress*, partially obtained.
  - Great Lakes Nutrient Initiative (for Lake Erie) – *requested*; pending.

  ii. Analyze trends in existing data (CE approach to understanding algae trends): exploratory analysis *in progress*, complete by December 2019

3. POSSIBLE SYNERGIES

…what are your thoughts?

Possible synergies

- If reconsidering the 42 Best Bets for the next [20] years, are there synergies with the public consultation in this research?
  - QUESTION 1: Can the identification/update of VECs contribute to identifying new GRMP Best Bets? → discuss today

- After the interviews and consultation, I will have people score, or rank, each VEC in a new criteria-based process. This will create an order of priority for short-listing or action.
  - QUESTION 2: Do any GRFMPIC members want to be part of this scoring?
  - QUESTION 3: Do GRFMPIC members want to participate in determining criteria for scoring?

Criteria
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)
We have control over changes to this indicator
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.
This indicator is important to me

Other questions

- Question from Sandra Cooke: is GRFMPIC interested in temperature data from this study area (e.g., is this important to monitor in large, warm, high-flow area)?

- Aspects of this research that are of interest to GRFMPIC?

- Other ideas for collaboration or coordination of activities?

Recap of research and questions posed to you

- Two main outcomes:
  - Improved monitoring framework – (1) map existing efforts, (2) review best practices, (3) interviews re: monitoring and decisions, (4) public consultation re: VECs, (5) framework co-creation
  - Cumulative effects case study – compile and analyze existing data re: Lake Erie algae problem

- Questions:
  - Can the identification/update of VECs contribute to identifying new GRFMP Best Bets?
  - Is GRFMPIC interested in temperature data from the lower Grand River/mouth to Lake Erie?
  - *Talk to me later (unless group-relevant)* if you want to be part of the VECs scoring process and/or determining criteria for scoring, or if you have thoughts on research direction or other ideas for collaboration/coordination

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THANK YOU FOR YOUR TIME AND FEEDBACK!

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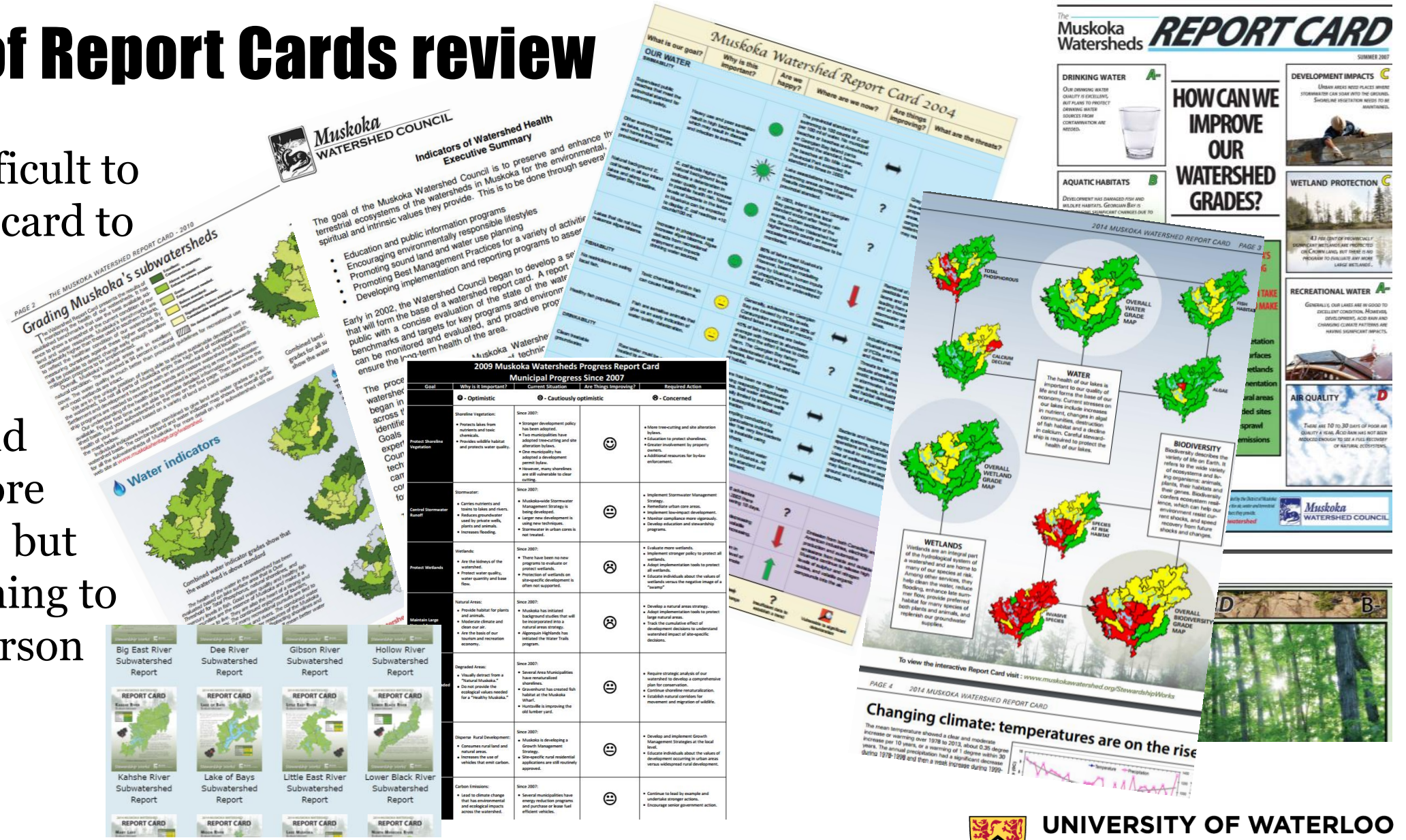
ADDITIONAL SLIDES 1

Outcomes of the exploratory study

Results of Report Cards review

- Trends difficult to infer from card to card
- Background reports more consistent, but overwhelming to average person



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Workshop on indicators and reporting

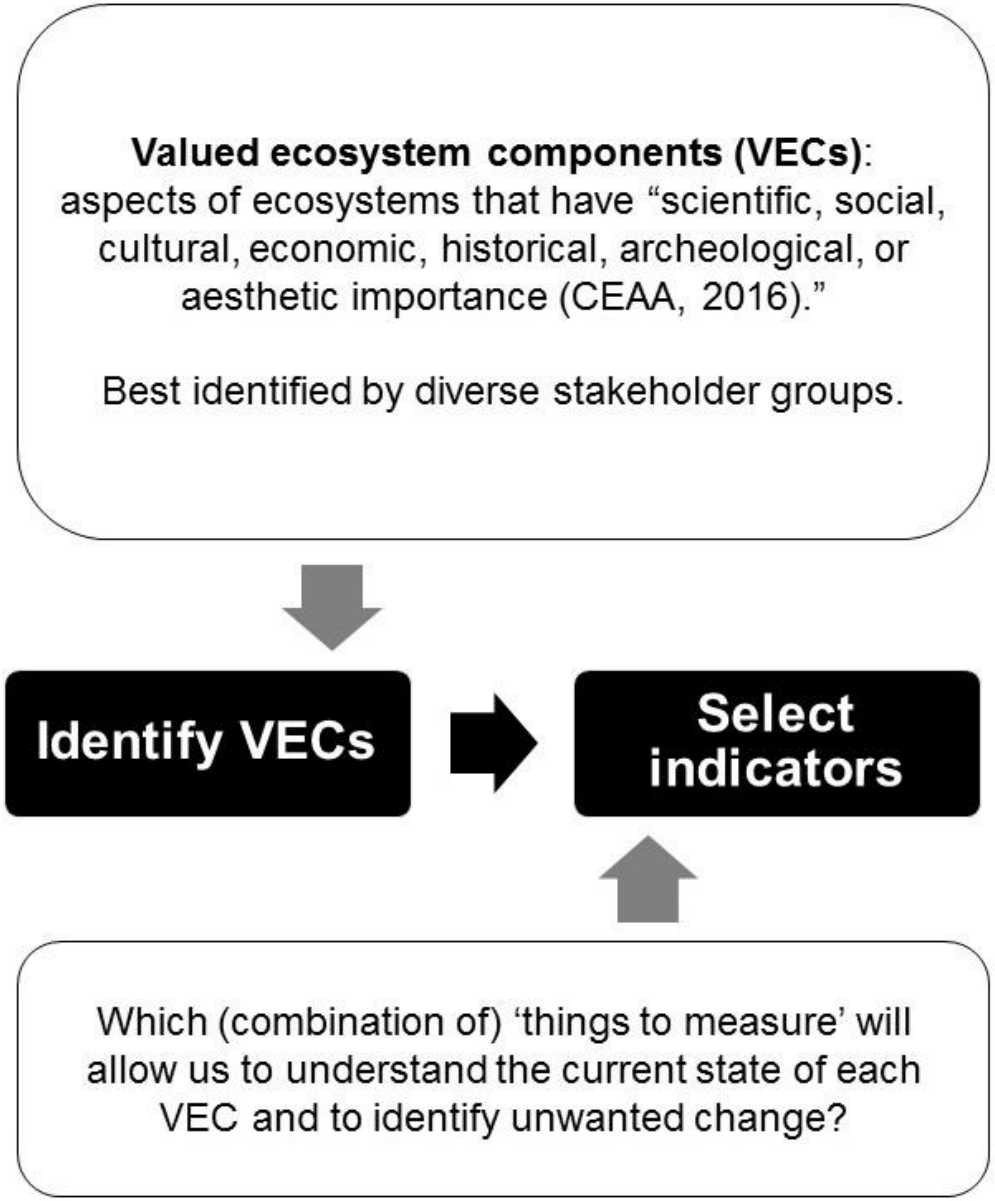
- **Workshop task**:
  - Address (high level) incongruent monitoring indicators
  - Improve communication in watershed report cards

- **Example indicators**: phosphorous, calcium, E.coli, dissolved organic matter, species composition, road salt runoff, amount of recreational and industrial development, etc.

*Eimers, C. (2016). *Cumulative effects assessment and monitoring in the Muskoka Watershed*. Report to the Canadian Water Network. [link]

A new way to prioritize monitoring indicators, tested in the Aug 5, 2016 workshop with the Muskoka Watershed Council.

Conventional Method



A new way to prioritize monitoring indicators, tested in the Aug 5, 2016 workshop with the Muskoka Watershed Council.

Conventional Method

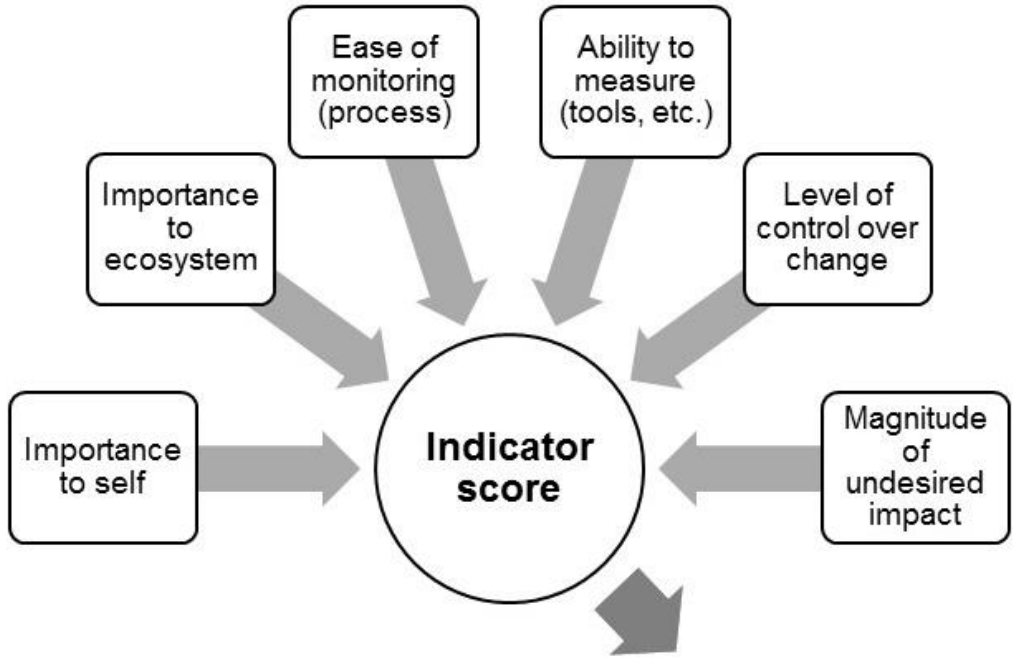
Valued ecosystem components (VECs): aspects of ecosystems that have "scientific, social, cultural, economic, historical, archeological, or aesthetic importance (CEAA, 2016)."

Best identified by diverse stakeholder groups.

Identify VECs → **Select indicators** → **Short-listing** → **Rank for priority**

Which (combination of) 'things to measure' will allow us to understand the current state of each VEC and to identify unwanted change?

Which indicators give a 'good enough' description of the VEC for decision making purposes, versus a complete ecological story.



New Method

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)						
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)						
We have control over changes to this indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator						
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

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This indicator is measurable given reasonably expected resources (to people, funds, time…)						
We have control over changes to t indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator						
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Before new method:

"We all know this will make the list"

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)	17	31	23	33	32	27
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)	33	22	25	30	25	20
We have control over changes to this indicator	18	20	18	27	24	23
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator	16	19	16	25	19	20
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator	20	21	17	27	21	20
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.	22	31	27	31	28	30
This indicator is important to me	24	31	25	34	31	28

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)	150	154	151	207	180	168
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)						
We have control over changes to this indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator						
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Summary of indicator ratings on a scale of 0 (least agreement) to 5 (strongest agreement) based on seven respondents (maximum sum of scores = 35).

Criteria	Secchi Depth	Algae	Calcium	Land Use	Wetland cover	Footprint (new)
I would include this indicator, by this or other name, in the Report Card (e.g. not just in the Background Report)						
This indicator is measurable given reasonably expected resources (tools, people, funds, time…)						
We have control over changes to this indicator						
We have effective mechanisms for correcting CURRENT unwanted changes to this indicator	6	4	5	1	2	3
We have effective mechanisms for correcting FUTURE unwanted changes to this indicator						
Unwanted changes to this indicator would result in serious impacts (directly or indirectly) on ecological and human systems.						
This indicator is important to me						

Main results

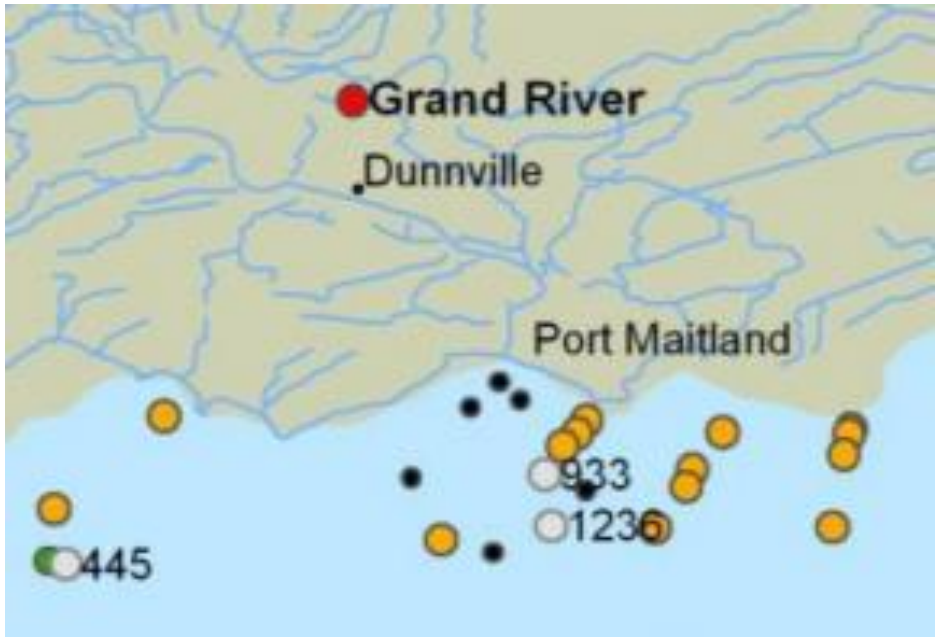
- **Monitoring indicators**: fewer, easily understood, consistent units,
  - Purposeful: geared towards use of results (triggers, goals, locally-connected)
  - Stakeholders must agree on what and how to measure
- **Explicit roles at the start**: monitoring and decision makers - purpose, goals, needs, capacity, outcomes, and protocols for issue response.
- **Time lags**: address discrepancy between monitoring (science), communication (to public and decision makers), and response.
- **Co-creation** of the monitoring framework is needed.
  - Meaningful stakeholder engagement and consideration of stakeholder perception must be improved, from the start and throughout the process.

ADDITIONAL SLIDES 2

Early outcomes of Phases 1a (existing monitoring), 3a (existing data), 3b (data trends and relationships)

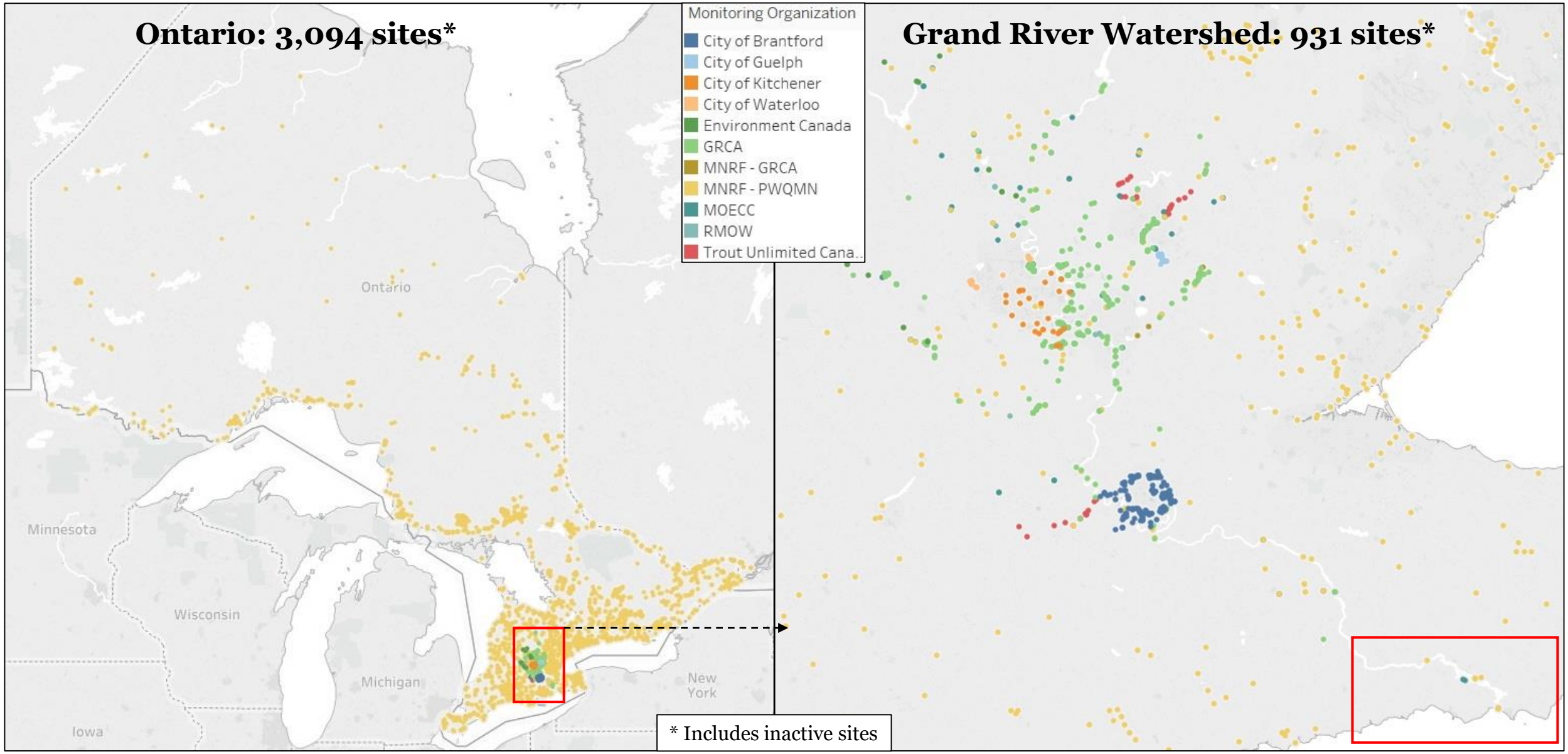
Lake Erie monitoring – Great Lakes Nutrient Initiative (GLNI)

- Water quality (every 8 hours)
  - Secchi depth, Photosynthetic Active Radiation (PAR), silica, fluoride, chloride, sulphate, nitrogen (multiple forms), phosphorous (multiple forms), TSS/turbidity, Chlorophyll *a*, particulate organic carbon and particulate organic nitrogen
- Mussel community and *Cladophora*
  - Biomass and P tissue concentration
- Hydrodynamics
  - Water movement



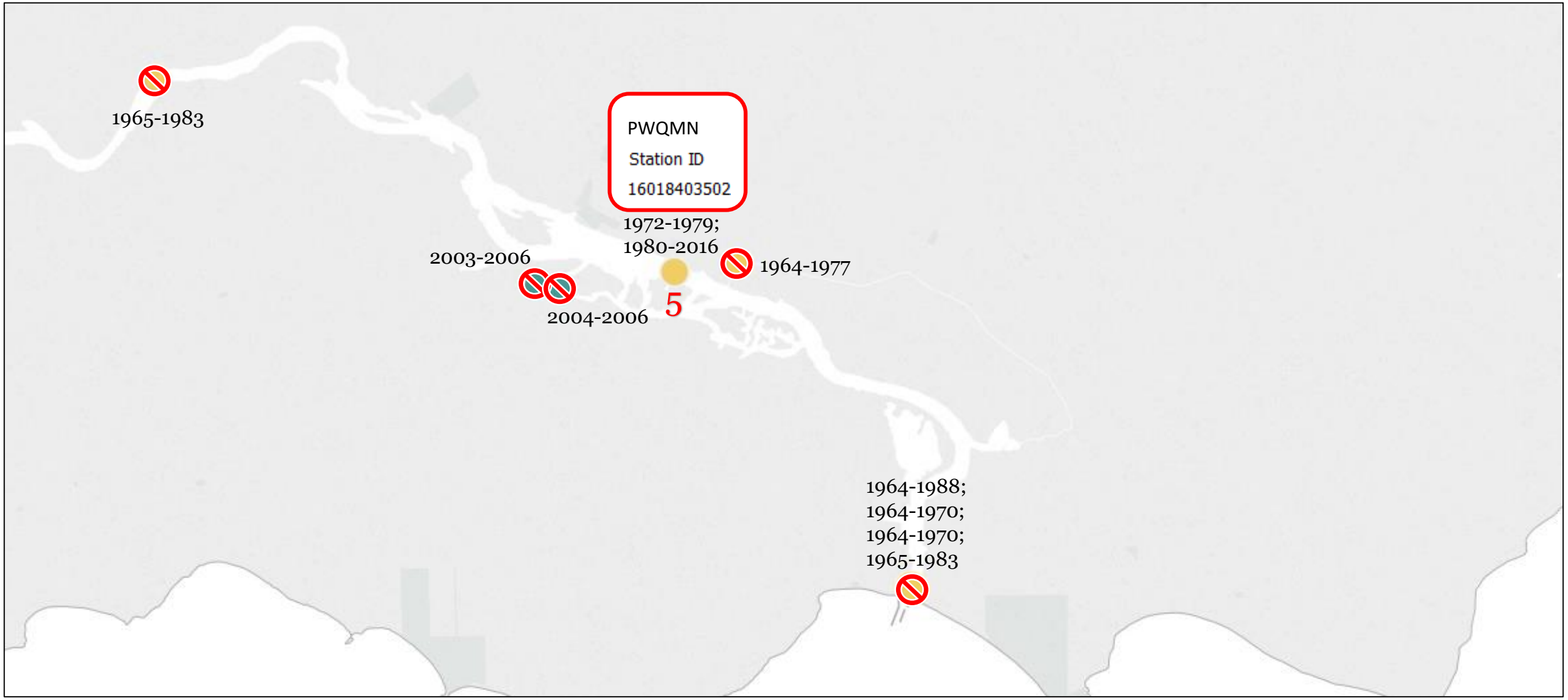
Dove, A., Backus, S., and Richardson, V. 2013. *Water Quality Monitoring for Lake Erie and the Great Lakes Nutrient Initiative (GLNI) 2011-2016*. http://www.lemn.org/LEMN2013-Files/Theme1/Dove_LEMN2013.pdf

Grand River Monitoring – PWQMN and GRCA (1964-2016)



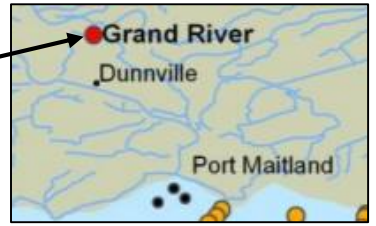
Monitoring in the GEI – Grand River portion (10 sites total)

Monitoring in the GEI – Grand River portion (1 site active)



Parameters currently measured in the study area

- Site 5 at the Dover Rd./R.R. 3 bridge (Dunnville, 1980-2016)
  - 43 parameters: alkalinity, aluminium, ammonium, barium, beryllium, bismuth, cadmium, calcium, chloride, chromium, cobalt, conductivity, copper, dissolved oxygen, hardness, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, nitrates, nitrite, nitrogen, pH, phenolics, phosphate, phosphorus, potassium, residue, silver, sodium, stream condition, strontium, temperature (water), tin, titanium, uranium, vanadium, zinc, zirconium
- One station upstream at Haldimand Norfolk R.R. 9 (York, 1977-2016)
  - Not in the aquatic area but within the terrestrial boundary, in case upstream site is needed
  - 16 parameters: ammonium, chloride, conductivity, dissolved oxygen, nitrates, nitrite, nitrogen, pH, phosphate, phosphorus, residue, temperature (water)
  - Possibly the GLNI Tributary Loading Station…?



Data: chlorophyll *a* (proxy for algae) and water quality

- **Chlorophyll *a***: collected by other Lake Futures researchers* from two MODIS satellites via NASA Goddard Space Flight Centre Ocean Biology Processing Group
  - Monthly averages produced from daily images for Lake Erie's Eastern basin
  - Algorithm calculated *Chl-a* concentration using empirical relationship derived from *in situ* measurements and remote sensing reflectance
  - Three seasons for 2008-2016: spring (Feb-Apr), summer (May-Jul), and fall (Aug-Oct)
    - Note: trends for all years have shown *Chl-a* increasing in the spring (~12%) and summer (~7%), but decreasing in the fall (~3%)
- **Water quality**: PWQMN data for years 2008-2014, averaging all within-year data from Dunnville station, trends observed using annual averages.

** Pereira Wilson, M., Kheyrollah Pour, H., Basu, N., van Cappellen, P.*

Correlation and T-tests (annual trends 2008-11, 2013-14)

Chl-a pairwise*	Significance (p≤0.05; one-tail, two-tail)		Pearson correlation
Ammonium	0.000	0.000	35.4%
Calcium	0.000	0.000	-82.6%
Magnesium	0.000	0.000	-65.4%
Nitrates	0.003	0.005	71.6%
Nitrite	0.000	0.000	47.5%
Nitrogen	0.136	0.271	34.7%
Phosphate	0.000	0.000	40.2%
Phosphorus	0.000	0.000	73.4%
Temperature	0.000	0.001	-56.0%

n=6